3D Printing geometry restrictions

Written by Robin Brockotter

Learn about how large a 3D print can be along with how element thickness, watertightness, and curved surfaces affect the quality of a print.

Table of contents

Introduction

This article discusses the size and geometric restrictions that must be considered when determining whether a model is suitable for 3D printing. These type of considerations apply to a wide range of industries who use CAD in design and are intending to get a design 3D printed from basic component modelling to complex architectural models.

Physical size

The table below identifies the build volume of a range of different printing technologies. It is important to note that as build volume increases more industrial printing technologies are typically used, increasing the overall price of the print. A guide on how to reduce to the size of (scale) a 3D model can be found here.

Technology	Maximum build volume
Desktop FDM (Ultimaker 2+)	220 mm x 223 mm x 205 mm
SLA (Form 2)	145 mm x 145 mm x 175 mm
SLS (EOS P 396 printer)	340 mm x 340 mm x 600 mm
Industrial FDM (Fortus 900mc)	914 mm x 610 mm x 914 mm

Build volumes for a range of 3D printing technologies

Element thickness

Often architects or game designers will produce elements within a design that have an infinitesimal thickness (hair, capes, sails etc.). These features are impossible to 3D print unless they meet a minimum printable feature size. These requirements vary by printing technology (the smallest possible feature size being 0.3mm printed with SLA technology). All elements within a model must comply to these feature restrictions to be able to print successfully.

Watertightness

Any models that are intended to be used for 3D printing should be completely manifold (watertight). Every edge on your model should have exactly 2 polygons attached to it and include no holes.

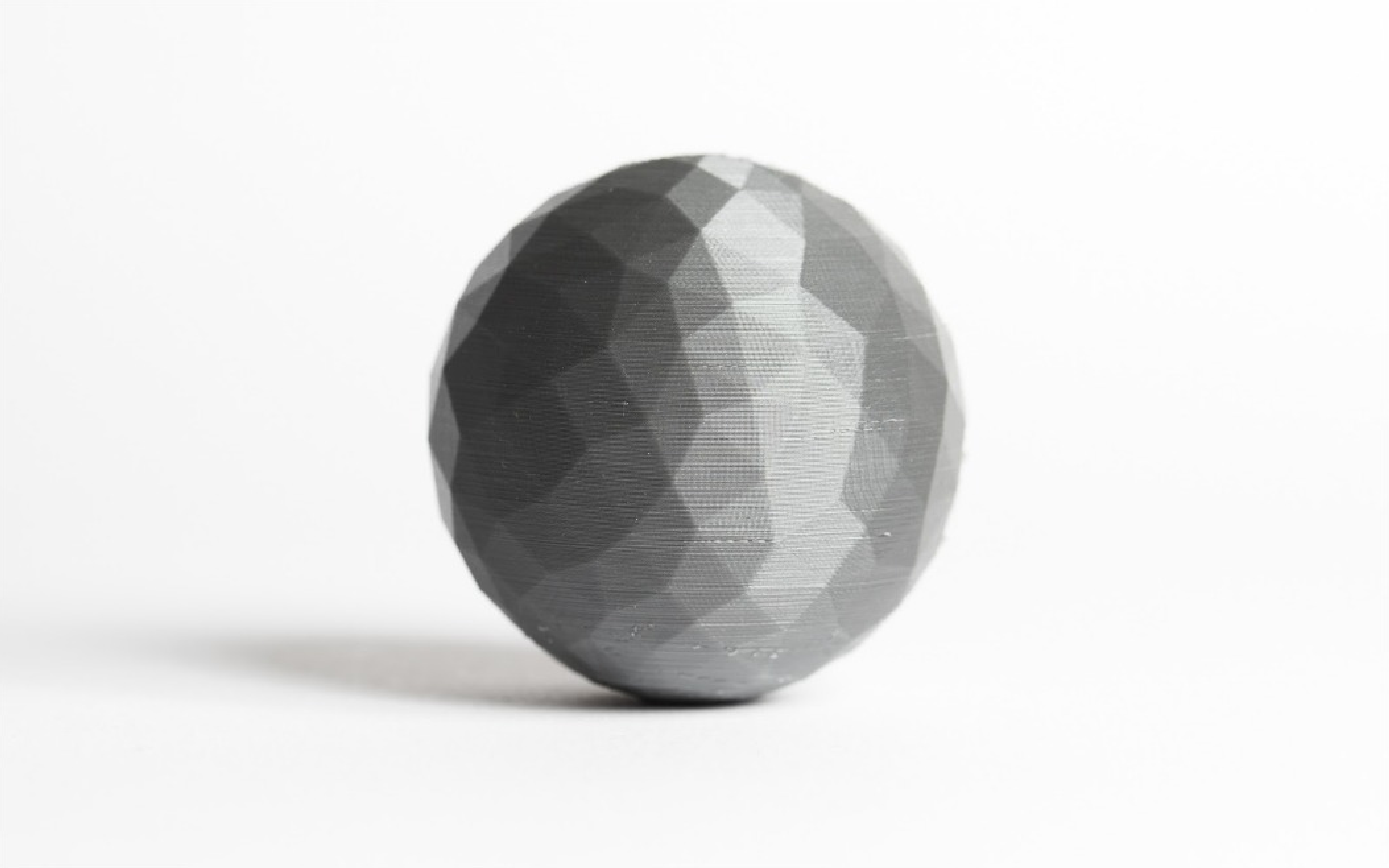
Models that are not manifold (watertight) might get misinterpreted by the software that generates the instructions for the 3D printer (slicer software). This might results in the object having inconsistent layers, holes or cause the model to be unprintable. Watertightness is often linked to the thickness of elements in a model with very thin features usually causing a problem.

Non-manifold issues are often not visible to the at the modelling stage. The simplest method of checking whether a model is watertight is to upload the model to an analyser program like Netfabb or Meshmixer. These programs detect model features that will cause issues at the 3D printing stage and offer repair options (often without impacting the overall aesthetics of the model).

Curved surfaces

Most CAD modelling programs such as Solidworks and Fusion360 use non-uniform rational basis spline (NURBS) to display surfaces of a model. When exporting your file to .STL for 3D printing it is important that an adequate number of polygons are used to represent a surface to ensure it will print with a smooth appearance. If not, the edges connecting individual polygons (essentially flat planes) will be visible in the final 3D print. When printing in high-detail 3D printing technologies such as SLA, DLP and PolyJet these polygons are often visible. This effect is more prominent with large scaled models (greater than 300 mm^3) where the polygon effect becomes more visible on curved surfaces.

The majority of modelling programs export solid models with an adequate number of polygons resulting in the 3D print that is perfect acceptable for most applications. If a higher polygon count is required to improve 3D print surface finish, analyser programs like Netfabb or Meshmixer allow this parameter to be varied.



A sphere with a low polygon count

Written by
Robin Brockotter
Ixi-Art's Hub – 3D Character Artist with history in Game Design.